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VIII.

CONTRIBUTIONS FROM THE PHYSICAL LABORATORY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

XXXI.—THE STRENGTH OF THE MICROPHONE CURRENT AS INFLUENCED BY VARIATIONS IN NORMAL PRESSURE AND MASS OF THE ELECTRODES.

By Annie W. Sabine.

Presented by Charles R. Cross, November 14, 1888.

The experiments described in the present paper, undertaken at the suggestion of Professor Cross, constitute a study of the variation of the current in the secondary circuit of a microphone transmitter, as related to variations in the normal pressure and in the mass of the electrodes of the microphone. They form a continuation of work of a similar character which has been prosecuted in the Rogers Laboratory during the past few years, and a portion of which has already been presented to the Academy.*

The instruments used were similar to those previously employed by Messrs. Patterson and Tucker, and described in the latter of the two articles just referred to. The electrodynamometer was calibrated by means of a Hartmann galvanometer, using reversals in the ordinary manner so as by four readings to eliminate the effect of the earth's magnetism on the suspended coil.

The microphone contact was set into vibration by the sound of a stopped organ-pipe (C_4 of 512 vibrations) kept as constant as possible by means of an air-blast furnished with a regulating air-chamber. Weights were gradually added to the upper (anvil) electrode, so that the mass of this and its pressure on the lower electrode were thereby increased by measured amounts. The weights added were usually in the form of thin copper washers weighing $\frac{8}{10}$ of a gram each, though fractions of this weight were used in some cases. One chromic acid cell was used as a battery.

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* See Proc. Am. Acad., Vol. XXI. p. 248; Ibid., Vol. XXIII. p. 228.

The character of the results obtained will be seen by an inspection of Figure 1, which gives the curve showing the relation between the normal pressure and the resulting current, with electrodes of the materials employed in the Blake transmitter, viz. a platinum hammer and a hard carbon anvil electrode. The abscissas represent the normal pressures, i. e. the added weights, and the ordinates the currents produced in the secondary. The data from which this curve is constructed will be found in the following table. The load is given in terms of the arbitrary unit employed; the currents are given in milliampères.

TABLE.

Load.	Current.	Remarks.
0	0	
.5	.18	
1.0	.46	Loud, good quality, fluttering.
1.5	.48	" " " "
2.5	.56	" " " "
3.0	.49	
3.5	.45	Faint, good quality.
4.0	.33	" " "
4.5	.21	
5.0	.19	

The curve shows a rapid rise at first, as the mass of the anvil electrode, and with it the pressure between the electrodes, is increased, which rise soon reaches a maximum, the curve then falling off rapidly at first, more slowly afterwards.

The nature of the curve is interesting, and requires explanation. In his article already referred to, Mr. G. W. Patterson, who obtained similar results to my own, considers the curve to be composed of two separate branches, the rising portion of the curve corresponding to a motion of the electrodes sufficient to break the circuit, and the falling portion to the case when the pressure is too great to allow this to occur. The curve (these Proceedings, Vol. XXIII. p. 235, Fig. 4) constructed upon this hypothesis greatly resembles one of the experimental curves shown in Fig. 3 of the same paper. There is less resemblance, however, to the lower curve in Fig. 3, and but little to the curve shown in Fig. 1 of this article, which was obtained under exceptional conditions of quietness of the piers upon which the apparatus was placed. The sound in a receiving telephone placed in the secondary circuit is so harsh for this portion of the curve, that one might well infer that actual breaks occurred; but this is very doubtful, and such breaking is certainly not essential to the production of the results which are obtained. In fact, the article referred to assumes that the varying pressure on the contact due to the action of the given sound-waves will always have the same maximum value, ± δ. This would be approximately true were the normal pressure between the two electrodes alone to be varied, but the effect of the addition of weights, as in the method of experiment adopted, is to increase the mass at the same time that the normal pressure is increased, and under these circumstances the effect of a sound-wave of given intensity will necessarily be to give to the corresponding pressure-variation a variable value, increasing with the added mass, and hence, with the form of apparatus used, as the normal pressure is greater. The effect of this will be to cause at first a gradual increase of current in the secondary,

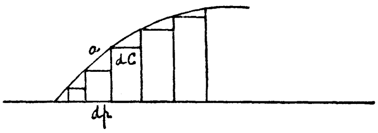

Fig. 2.

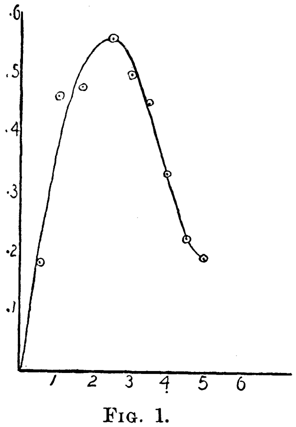

Fig. 1.

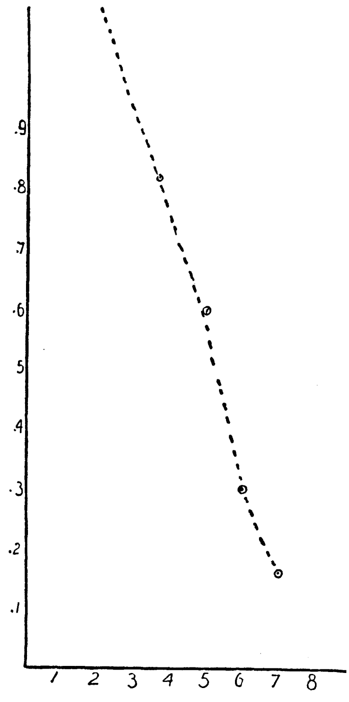

Fig. 3.

which increase is succeeded by a diminution of current when the mass is still further increased. This will be apparent from an inspection of the curve shown in Figure 2, which illustrates in a general manner the relation of the pressure between the electrodes to the current in the primary circuit.

In this the momentary changes in pressure, Δp, $\Delta p'$, $\Delta p''$, etc., due to the sound-waves, and corresponding to loads and normal pressures p, p', p'', etc., have increasing values within certain working limits, owing to the increasing mass of the anvil electrode. The currents in the primary also increase, though at a gradually diminishing rate, as the pressure between the electrodes is increased, so that the increments of current, Δc, $\Delta c'$, $\Delta c''$, corresponding to the pressure-changes Δp, $\Delta p'$, $\Delta p''$, have increasing values up to some point, as a, after which they decrease. This being the case, it is evident that the current in the secondary will at first increase to a maximum, and afterwards diminish, since the currents in the secondary corresponding to pressures p, p', p'', etc. will be proportioned to Δc, $\Delta c'$, $\Delta c''$, etc., and this is precisely the curve which is obtained in the experiments. The explanation just offered seems therefore to be the true one.

The matter was still further tested by carrying out a set of experiments similar to those already described, except that the variations in normal pressure were brought about by means of a spring instead of by adding weights. In such a case the successive values of Δp in the curve (Fig. 2) would be of the same magnitude, while Δc would continually diminish. The current in the secondary should therefore have its maximum value when the initial normal pressure is least, and continually diminish as that pressure becomes greater.

The experimental results verified this conclusion, as will be seen by reference to Figure 3, in which the normal pressures are represented by abscissas, and the currents in the secondary by ordinates, as before. The curve is approximately a straight line. It is possible that the deviations from this are due to instrumental imperfections, as the apparatus used did not allow of more than an approximate determination of the pressure applied by the spring.

Rogers Laboratory of Physics,
June, 1888.